REMARKS

AMENDMENTS TO SPECIFICATION

Applicant amends the specification to correct minor typographical errors and to insert "less than or equal to" symbols that were inadvertently omitted from page 5, line 9 and page 5, line 13. The omission and its correction are readily apparent from the surrounding context. For example, on page 5, line 9-10, the variables LSL_i and USL_i are defined as "lower and upper specification limits for performance attribute y_i." Hence, no new matter is introduced.

Applicant notes that the detailed description portion of the specification uses the term "viewing pane" for regions of the display that can contain either performance graphs or decision graphs. For example, in the last paragraph on page 6, the specification states that:

> "[t]o show the hyper-dimensional decision space, the described representation utilizes a set of viewing panes, each of which corresponds to one mutual relation of design parameters."

The existence of "viewing panes" in the performance space is indicated on page 9, lines 8-9, in which the specification states that

> "a convex hull algorithm can be applied to each viewing-pane in the decision space and the performance space."

For example, FIG. 10 shows twenty-one viewing panes, six of which contain decision graphs, three of which contain performance graphs, and twelve of which contain control graphs.

Applicant amends selected portions of the detailed description to make the terms used therein conform to those already used in the claims and in the summary section of the specification. This amendment enhances the clarity of the claims without introducing new matter.

CLAIM REJECTIONS

Applicant addresses first the rejections under 35 USC 112, followed by the double-patenting rejection and the rejections under 35 USC 103.

REJECTIONS UNDER 35 USC 112

Rejection re "Processor"

In point 2 on page 9, the Office Action suggests that there is insufficient antecedent basis for the recitation of a processor in claim 1.

In response, Applicant draws attention to the discussion on pages 17-18 of the specification concerning the hardware for implementing the invention. In particular, beginning on the last line on page 17, the specification states that:

> "The instructions can be executed on a general purpose digital computer having a processor, a keyboard and/or mouse for communicating with a designer, and an output device, such as a video display monitor."

rejection re "Control Graphs"

In point 3 on page 9, the Office Action asserts that there is insufficient antecedent basis for the limitation

> "a plurality of control graphs…at least one of said control graphs illustrating an effect of a first design variable on a first performance attribute"

because the claim allegedly

> "dose [sic] not specify the number of control graphs that shows which one of control graphs illustrating an effect of a first design variable on a first performance attribute."

Applicant draws attention to the discussion of FIGS. 10 and 14. In particular, FIG. 10 shows control graphs that collectively relate four design variables (height, width, mid-thickness, and bottom thickness) and three performance attributes (stress, vertical deflection, cross-area). Since there are four design variables and three performance attributes, there are twelve control graphs. In addition, the term "control graph" is introduced into the specification beginning on the

last line of page 1. Applicant asserts that one of ordinary skill in the art who reads the text and figures will recognize the meaning of the term "control graph" in the claims.

Applicant has difficulty understanding the further comment in point 3 concerning specifying the number of control graphs. In an effort to explain claim 1, Applicant provides the following example of how claim 1 may be interpreted in the context of FIG. 10.

Within the context of FIG. 10, the limitation of "at least one...control graph" could be read on the upper leftmost control graph, in which case the "first design variable" would be "height" and the "first performance attribute" would be "cross-area." However, the "at least one control graph" can also just as easily read on the bottom leftmost control graph, in which case the "first performance attribute" becomes "stress" and the first design attribute becomes "height."

It may be useful, in better understanding the invention, to note that the various graphs shown in FIG. 10 and 14 correspond to the schematic diagram shown in FIG. 1. The control graphs discussed above correspond to the region designated "Function Matrix" in FIG. 1. The performance graphs and the decision graphs, both of which are discussed in more detail below, are in the regions designated "Performance Space" and "Decision Space" respectively in FIG. 1.

Rejection re "Performance Graphs"

In point 4 on page 9, the Office Action asserts that there is insufficient antecedent basis for the limitation

> "a plurality of performance graphs...at least one of said performance graphs showing a relationship between said first performance attribute and a second performance attribute"

because the claim

> "dose [sic] not specify the number of performance graphs that shows which one of performance graphs showing a relationship between first performance attribute and a second performance attribute."

Applicant respectfully draws attention to the discussions of performance graphs in the specification, for example in connection with FIGS. 10 and 14. In particular, FIG. 10 shows performance graphs that collectively relate any two of the three performance attributes (stress,

vertical deflection, cross area) to each other. Since there are three ways to combine three performance attributes two at a time, there are three performance graphs.

In addition, the term "performance graph" is introduced into the specification beginning on page 2, line 2. Applicant asserts that one of ordinary skill in the art who reads the text and figures will recognize the meaning of the term "performance graph" in the claims.

Applicant has difficulty understanding the further comment in point 4 concerning specifying the number of performance graphs. In an effort to explain claim 1, Applicant provides the following example of how claim 1 may be interpreted in the context of FIG. 10.

FIG. 10 shows three performance graphs arranged in a triangle to the left of the twelve control graphs. Within the context of FIG. 10, the limitation of "at least one...performance graph" could be read on the topmost performance graph, in which case the "first performance attribute" would be "cross area" and the "second performance attribute" would be "vertical deflection." However, the "at least one performance graph" can just as easily read on the bottom performance graph, in which case the "first performance attribute" becomes "stress" and the second design attribute becomes "Vertical deflection."

Rejection re "Decision Graphs"

In point 5 on page 9, the Office Action asserts that there is insufficient antecedent basis for the limitation

> "a plurality of decision graphs...at least one of said decision graphs showing a relationship between said first design variable and a second design variable"

because the claim

> "dose [sic] not specify the number of decision graphs that shows which one of decision graphs showing a relationship between first design variable and a second design variable."

Applicant respectfully draws attention to the discussion of decision graphs in the specification, for example in connection with FIGS. 10 and 14. In particular, FIG. 10 shows decision graphs that collectively relate any two of the four design variables (height, width, mid

thickness, bottom thickness) to each other. Since there are six ways to combine four design variables two at a time, there are six decision graphs shown in FIG. 10. These six decision graphs are arrayed in a triangle above the twelve control graphs.

In addition, the term "decision graph" is introduced into the specification beginning on page 2, line 2. Applicant asserts that one of ordinary skill in the art who reads the text and figures will recognize the meaning of the term "decision graph" in the claims.

Applicant has difficulty understanding the comment concerning specifying the number of decision graphs. In an effort to explain claim 1, Applicant provides the following example of how claim 1 may be interpreted in the context of FIG. 10.

Within the context of FIG. 10, the limitation of "at least one decision graph" could be read on the topmost decision graph, in which case the "first design variable" would be "height" and the "second design variable" would be "bottom thickness." However, the "at least one decision graph" can just as easily read on the bottom leftmost decision graph, in which case the "first design variable" becomes "height" and the second design attribute becomes "width."

Rejection re "Design Interface"

In point 6 on page 10, the Office Action asserts that there is insufficient antecedent basis for the limitation

> a design-interface coupled to said input of said processor, said design-interface enabling a user to manipulate said first design variable to control said first performance attribute.

In response, Applicant draws attention to discussions of antecedent basis found in the specification. For example, a design interface is discussed in the following passage:

> "The computer-implemented display also includes a *design interface* though [sic] which the designer interactively manipulates values of the design variables so as to control the performance attributes. Because of its intuitive nature, the *design interface* preferably includes an adjustable slider or scroll box in which movement of the scroll box or slider changes the value of the design variable. Alternatively, or in addition to the adjustable slider or scroll box, the *design interface* can include a text box or field into which the designer can enter a numerical value for the design variable. The text box or field is

particularly useful when the value of a design variable needs to be changed by an amount that would require infinitesimal motion of the slider."[1] [emphasis supplied]

In the illustrated embodiment, the coupling of the design interface to the processor is thus a coupling of the same type as that used when manipulating graphical elements on a display or otherwise entering data on a display. However, the exact nature of the coupling is not of particular significance in defining the invention.

Rejection of claims 2-4

In point 7 on page 10, the Office Action rejects these claims for the same reason as given for claim 1. Accordingly, Applicant reasserts the comments made above in connection with claim 1.

Rejection of claim 5

In point 8 on page 10, the Office Action rejects this claim because the term "random variable and probability distribution" is unclear.

According to the MPEP, "[a] claim is indefinite when it contains terms whose meanings are unclear."[2] Terms such as "random variable" and "probability distribution" are well-known terms from probability theory. For example, the attached pages, copied from the McGraw-Hill Dictionary of Scientific and Technical Terms, 4th Ed., provide definitions for both of these terms. As such, their presence in claim 5 does not render that claim indefinite.

Rejection of claims 6 and 7 and of claim 10

In point 9 on page 11, the Office Action rejects claim 6 because the term "permissible values" allegedly lacks antecedent basis. Similarly, in point 10 on page 11, the Office Action rejects claim 10 because the term "weight" allegedly lacks antecedent basis.

In response, Applicant draws attention to page 8, lines 13-14 in which the specification states that:

---

[1] Applicant's specification, page 2, lines 12-20.
[2] MPEP 2173.05(e).

"a designer can apply *a weighting coefficient* for different performance attributes"[emphasis supplied]

With regard to the term "permissible values", Applicant draws attention the specification's use of the word "value" in the context of performance attributes in the first paragraph of the "Background" section on page 1:

> "The engineering design process can be viewed as the process of attaining specified *values of one or more performance attributes* by manipulating one or more design variables within limits specified by one or more corresponding constraints."[emphasis supplied]

Applicant submits that the adjective "permissible" has a common English meaning as set forth by the enclosed dictionary definition from Webster's Ninth New Collegiate Dictionary.

It is not possible to specify a specific range of permissible values. The choice of what values are permissible and what values are not would inevitably depend on the specific design problem being addressed, on the units used to express various quantities, on whether those quantities are normalized or otherwise scaled, and on a host of other factors that have nothing to do with the invention.

Rejection of claim 8

In point 11 on page 11, the Office Action rejects claim 8 as having the same limitations as claim 6, a claim from which claim 8 depends.

In response, Applicant reiterates the arguments set forth in connection with claim 6.

Rejections of claims 9

In point 12 on page 11, the Office Action rejects claim 9 because the term "array" lacks antecedent basis in the specification.

Applicant draws attention to FIGS. 10 and 14, both of which plainly show an array of control graphs . In particular, FIG. 10 shows a 3×4 array of control graphs and FIG. 14 shows a 2×4 array of control graphs. In addition, on page 2, lines 4-6, the specification states that

> "[f]or ease of visualization *the control graphs are arranged to form an array* in which each row is associated with a performance attribute and each column is associated with a decision variable." [emphasis supplied]

Rejection of claim 10

In point 13 of page 11, the Office Action rejects claim 10 because it allegedly recites the same limitation as claim 9, the claim from which it depends.

In response Applicant reiterates the arguments set forth in connection with claim 9.

Rejection of claim 11

In point 14 on page 11, the Office Action rejects claim 11 because "allowable values" allegedly lacks antecedent basis.

In response, Applicant draws attention to the specification's use of the term "allowed range of values" on page 2, lines 9-11:

> "Optionally, to assist a designer in visualizing the constraints on the design, *the decision graph shows the allowed range of values for both design variables*." [emphasis supplied]

Rejection of claim 12

In point 15, the Office Action states that claim 12 "recites the same limitations as rejection of claims 9 and 1."

In response, Applicant reiterates the arguments set forth above in connection with claims 9 and 1.

Rejection of claim 13

In point 16 on page 11, the Office Action rejects claim 13 because the term "Pareto optimal" is allegedly unclear.

Applicant submits that the term "Pareto optimal" is well known in arts such as mathematical programming, optimization theory, and operations research.

Moreover, Applicant's specification also includes the following brief discussion of Pareto optimality on page 8, lines 18-26:

"The method and system of the invention are extensible to m performance attributes and n design parameters. Let the performance attributes $Y^* = \{y_1^*, y_2^*, ..., y_m^*\} \in S$, where S is the total performance space, $\{Y \in R^m \mid LSL \leq Y \leq USL, LCL \leq X \leq UCL, Y=f(X)\}$. Y* is defined as Pareto optimal (non-inferior) if and only if there exists no other $Y' = (y_1', y_2', ..., y_m') \in S$, where $Y' \neq Y^*$, such that $y_j' \leq y_j^* \; \forall j$ (without loss of generality, the smaller value of the performances is assumed to be better). Therefore, the boundary BCD of FIG. 5 is the Pareto Optimal set. Any element in the Pareto Optimal set represents one "optimal" design vector. The term "optimal" here means that there is no way to improve the performance of one attribute without causing a decrease in the performance attribute."

Since the meaning of "Pareto optimal" is well known in the art, and since the term is also defined in the specification, Applicant requests reconsideration and withdrawal of this rejection.[3]

Rejections of claims 14-39

In points 17-18 on page 11, the Office Action rejects these claims for the same reasons set forth for claims 1-13.

In response, Applicant reiterates the arguments set forth above in connection with claims 1-13.

Summary

Applicant requests that the Examiner withdraw all rejections made under section 112 because all allegedly missing antecedent bases are present in the specification and figures as filed, and any terms not defined in the specification are known to those of skill in the art.

DOUBLE-PATENTING REJECTION

In points 19 and 20 on page 12, the Office Action alleges that claims 14-26 and claims 27-39 are substantial duplicates of each other. Accordingly, the Office Action raises an objection to those claims on the basis of 37 CFR 1.75.

As the Office Action points out, claims 14 and 27 have different preambles. In fact, the preambles are so different that claims 14-26 and claims 27-39 are in different statutory classes altogether. Claims 14-26 are method claims, whereas claims 27-39 are drawn to an article of

[3] MPEP 2173.05(a) ("The meaning of every term used in a claims should be apparent from the prior art or from the specification and drawings at the time the application is filed").

manufacture. These claims do not cover the same subject matter precisely because of the difference in wording pointed out by the Office Action. Moreover, both these claims are in different statutory classes from claims 1-13. Accordingly, Applicant requests withdrawal of the objection under 37 CFR 1.75.

REJECTIONS UNDER 35 USC 103

Rejection based on *Sugino*

The office action rejects claims 1-3, 5-8, 11, 14-21, 24, 27-34, and 37 as being allegedly rendered obvious by Sugino.[4] Applicant traverses this rejection for reasons set forth below.

In many systems, a single design variable controls the values of two or more performance attributes. In such systems, it is often the case that a system designer must make trade-offs. In doing so, the designer identifies the most important performance attributes and biases the choice of a value of the design variable so as to favor optimizing those performance attributes at the expense of optimizing the less important performance attributes. What *Sugino* describes is a system for quantifying such trade-offs.

In an example used throughout *Sugino*, the single design variable is the "chip pad position." This single design variable governs the values of two performance attributes, namely: "chip pad" and "stress during reflow soldering." FIGS. 5 and 6 show polynomial approximations of the design variable's effect on both of these performance attributes. Normalized versions of these polynomial approximations ($f_1(x)$ and $f_2(x)$) are shown in FIG. 7.

The *Sugino* system defines an objective function $F(x)$[5] as the weighted sum of the normalized approximations $f_1(x), f_2(x), \ldots$:

$$F(x) = a_1 f_1(x) + a_2 f_2(x) \ldots_1$$ [6]

---

[4] *Sugino*, et al., U.S. Patent No. 5,287,284.
[5] *Sugino*, col. 8, lines 33-43, referring to $F(x)$ as the "evaluation formula."
[6] *Sugino*, Equation (3) in column 8.

The *Sugino* system determines the value of the design variable x that maximizes the objective function $F(x)$. The *Sugino* system then displays the objective function $F(x)$ and the normalized approximations $f_1(x)$, as shown in FIG. 10.[7]

Sugino lacks any discussion of multivariate optimization problems in which several design variables jointly control values of several performance attributes. Without at least two design variables, it is impossible to even define a relationship between a first and second design variable, much less show such a relationship on a decision graph as required by claim 1. Accordingly, it is not possible for *Sugino* to teach or suggest the claimed limitation of

> "a plurality of decision graphs ..., at least one of said decision graphs showing a relationship between said first design variable and a second design variable"

Sugino also fails to teach or suggest the claimed limitation of

> "a plurality of performance graphs ..., at least one of said performance graphs showing a relationship between said first performance attribute and a second performance attribute"

Sugino shows graphs in which a performance attribute is plotted as a function of the design variable. For example, FIG. 10 shows normalized performance attributes $f_1(x)$ and $f_2(x)$ plotted as a function of the design variable x. *Sugino* also shows $F(x)$, which is essentially a composite performance attribute, plotted as a function of x. However, nowhere does *Sugino* teach or suggest one performance attribute plotted as a function of another performance attribute, as required by the foregoing claim limitation.

For reasons set forth above, *Sugino* neither teaches nor suggests the limitations recited in claims 1-49. Accordingly, Applicant requests reconsideration and withdrawal of the section 103 rejection of claim 1 and all claims dependent thereon.

---

[7] *Sugino*, col. 8, lines 45-50 ("Thereafter, the optimum value of the design parameter is displayed ...together with a graph representing the design parameter change of the evaluation value obtained by the trade-off evaluation unit **28**." The operator judges whether or not this design parameter value is reasonable on the basis of this display, and changes the weighting coefficient in the evaluation formula $F(x)$)

Rejection based on *Sugino* and *Daniels*

Claims 4, 9-10, 12-13, 22-23, 25-26, and 38-39 stand rejected as being rendered obvious by the combination of *Sugino* and *Daniel*.[8] Applicant traverses this rejection for reasons set forth below.

As noted above, Sugino fails to teach the limitations of

"a plurality of decision graphs ..., at least one of said decision graphs showing a relationship between said first design variable and a second design variable"

Sugino also fails to teach or suggest the claimed limitation of

"a plurality of performance graphs ..., at least one of said performance graphs showing a relationship between said first performance attribute and a second performance attribute"

Like *Sugino*, *Daniel* fails to teach these claim limitations. Accordingly, the combination of *Sugino* and *Daniel* also fails to teach these claim limitations. Therefore, the combination of *Sugino* and *Daniel* fails to render obvious any of the pending claims. Accordingly, Applicant requests reconsideration and withdrawal of the section 103 rejection of claim 4, 9-10, 12-13, 22-23, 25-26, and 38-39.

CONCLUSION

Attached is a marked-up version of the changes being made by the current amendment.

---

[8] *Daniel Jr.*, et al. U.S. Patent No. 6,289,299.

Now pending in this application are claims 1-39, of which claims 1, 14, and 27 are independent. Applicant asks that all claims be allowed. No additional fees are believed to be due in connection with the filing of this response. However, to the extent fees are due, or if a refund is forthcoming, please adjust our Deposit Account No. 06-1050.

Respectfully submitted,

Date: December 12, 2002

Faustino A. Lichauco
Reg. No. 41,942

Fish & Richardson P.C.
225 Franklin Street
Boston, Massachusetts 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

response2.doc

Version with markings to show changes made

In the specification:

The paragraph beginning on page 5, line 6 is amended as follows:

--Each well-defined design objective is one performance attribute. The set of performance attributes, together with the expected satisfaction limits constitutes a specification. Denoting the i^{th} performance attribute as y_i, a typical specification can be expressed as $LSL_i \leq y_i \leq USL_i$ where LSL_i and USL_i denote the lower and upper specification limits for performance attribute y_i. Without loss of generality, a one-sided specification can be formed by substituting $-\infty$ or $+\infty$ for the unspecified limits.--

The paragraph beginning on page 5, line 12 is amended as follows:

--Suppose $y_i = f_i(\mathbf{X})$, where **X** is the design vector, $\mathbf{X} = \{x_1, x_2, ..., x_j, ..., x_n\}$ and $LCL_j \leq x_j \leq UCL_j$. By holding design parameters other than x_j constant, the sensitivity $y_i = f_i(x_1^c, x_2^c, ..., x_j, ..., x_n^c)$ can be plotted, as shown in FIG. 2. To ease the computational burden, the function is linearized to acquire the analytical feasible decision space and performance space. However, the method and system of the invention are equally applicable for non-linear functions.--

The paragraph beginning on page 7, lines 9 is amended as follows:

--Referring now to FIG. 3, the [~~The~~] algorithm works in parallel for each [~~viewing pane~~] decision graph in the decision space. Because each specification *hs* intersects the convex decision space at most twice, *m* specifications cost no more than 2*m* intersection calculations. Therefore, it requires *O*(*m*) time to solve the feasible region in the decision graph of FIG. 7 [~~local decision space for one viewing pane~~]. --

The paragraph beginning on page 8, line 27 is amended as follows:

--The convex property of the linear problem significantly simplifies the solution of the feasible space. Based on the convexity, the decision space and the performance space are the convex hulls of the same extreme points in two different spaces. Therefore, the first critical step is to find these extreme points. This can be done by solving the system equations composed of *n* design constraints. Every combination of *n* constraints from the specification and the parameter limits corresponds to a potential extreme point. The confirmation of this intersection point comes from the feasibility validation of the solution. Any valid intersection point of *n* constraints is one extreme point of the feasible design space. After all extreme points are acquired, a convex hull algorithm can be applied to each [~~viewing pane~~] decision graph in the decision space and each performance graph in the performance space. Alternatively, the extreme points can be

traced to find the facet of the feasible polytope. Each facet represents one specification or parameter limit. The linear system of equations $F \cdot X = Y$ can be solved by LU decomposition. Given the fact that there are 2^n system equations sharing the same coefficient matrix **F** but different vectors **Y**, the LU decomposition, shown in FIG. 5A, reduces the computation time. [~~An outline of the algorithm is given as:~~]--

The paragraph beginning on page 2, line 12 is amended as follows:

--The computer-implemented display also includes a design interface [~~though~~]through which the designer interactively manipulates values of the design variables so as to control the performance attributes. Because of its intuitive nature, the design interface preferably includes an adjustable slider or scroll box in which movement of the scroll box or slider changes the value of the design variable. Alternatively, or in addition to the adjustable slider or scroll box, the design interface can include a text box or field into which the designer can enter a numerical value for the design variable. The text box or field is particularly useful when the value of a design variable needs to be changed by an amount that would require infinitesimal motion of the slider.--

In the claims:

Claim 33 has been amended as follows:

33. The computer-readable medium of claim **27** wherein said software further comprises instructions for assigning[~~,~~] a weight to said first performance attribute, thereby indicating an importance of said selected performance attribute relative to said second performance attribute.